INSTRUCTION MANUAL

F. M. SIGNAL GENERATOR

MODEL 100-A

New London Instrument Company
NEW LONDON, CONNECTICUT

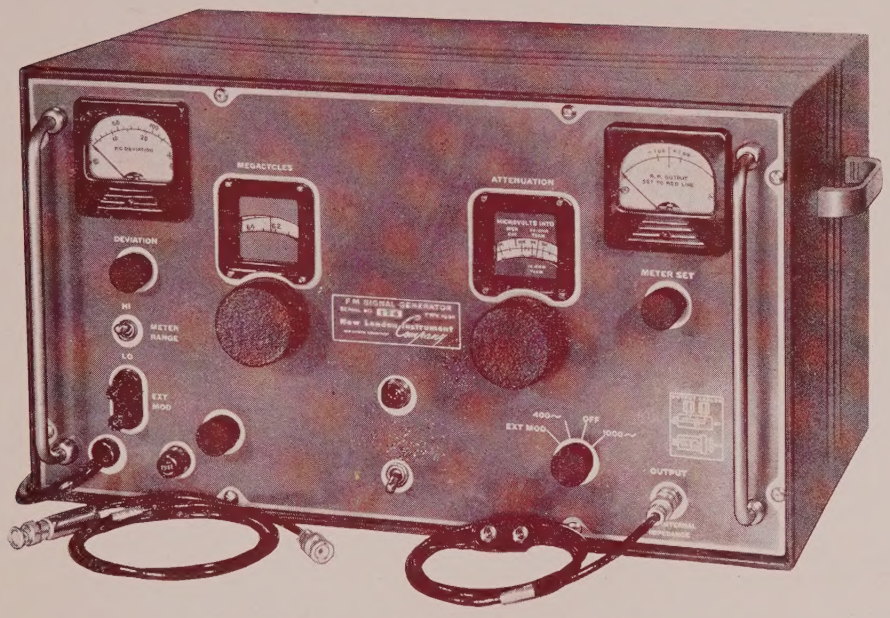

Fig. 1. F. M. Signal Generator 100A

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PART I

GENERAL DESCRIPTION

F. M. Signal Generator 100A represents a new departure in signal generator design. It is especially well fitted for testing the alignment, band width and sensitivity of frequency modulated receivers—either in the laboratory, on the service bench or on the production test line.

With the problems of the user in mind, great care is taken both in the design and the manufacture of the 100A to achieve precision of performance and yet retain convenience in operation.

A novel circuit with a single tube in the r-f compartment is used, instead of the three or four usually employed in such generators. No reactance tube is used. This minimizes drift, which might otherwise result from variation in the transconductance of such a tube. Further, the absence of multiple tubes eliminates the possibility of drift caused by excess heat in the r-f compartment.

The unusual circuit also results in low modulation distortion, low A-M and low hum. Since no mixing or multiplication is used, and since the oscillator frequency is the output frequency, there are very low spurious outputs.

Leakage is minimized by the use of a heavy, silver-plated cast bronze cavity to enclose the r-f compartment.

For convenient use, a single tuning range covering the whole 20 to 110 mc. is incorporated in the 100A. This feature, which eliminates band switching, is facilitated by the absence of a reactance tube.

A precise piston attenuator gives continuous control of the output voltage over the ranges of 100,000 to 0.1 or 20,000 to .02 microvolts. A deviation meter provides easy deviation setting. All dials are large and readable.

Functionally, signal generator 100A consists of the following:

(1) An audio oscillator that produces a sinusoidal oscillation at either 400 or 1,000 cps.

(2) An audio amplifier.

(3) An r-f oscillator which produces an r-f output from 20 to 110 mc.

(4) A power supply which furnishes regulated power to the signal generator.

(5) A variable resistance tube whose output voltage is adjusted automatically.

(6) An output attenuator that provides a calibrated output from the signal generator.

TECHNICAL SPECIFICATIONS

Frequency range:	20 to 110 mc ± ½% ± 0.2 mc. Single tuning range; errorproof dial.
Output:	Unmodulated or f-m
Internal modulation frequencies:	400 and 1000 cycles
External modulation:	100 to 10,000 cycles
Impedance into external modulation terminals:	0.5 megohm
Leakage:	Very low. Cannot be measured with 0.1 microvolt detector.
Output cables:	W1: 25 ohms ± 3 ohms self impedance, with binding posts. W2: 9 ohms ± 1 ohm at 50 mc. self impedance, with BNC fitting, mates with UG-290/U. Cables terminated at **both** ends to reduce mismatch reflections.
Panel connector:	Mates with BNC UG-88/U
Generator self-impedance without cable:	50 ohms
Output voltages:	With W1 cable, 100000 to 0.1 microvolts (-37 to -157 db below 1 watt into 50 ohms) With W2 cable, 20000 to 0.02 microvolts (-44 to -164 db below 1 watt into 10 ohms)
Spurious frequencies:	Harmonics of oscillator only. No other spurious outputs.
Attenuator:	Piston type, accuracy ± 10%, usable to 0.1 microvolts with W1 cable, lower with W2 cable.
Frequency deviation:	Two ranges, 0 to 30 kc and 0 to 150 kc, ± 5% of full scale at 1000 cycles
Tubes:	6BJ6, 6AR5, 12AU7, 6AV5, 6BH6, 5651, 6AS5
A-c input	105-125 volts, 50-60 cycles, 65 watts
Weight	45 lbs

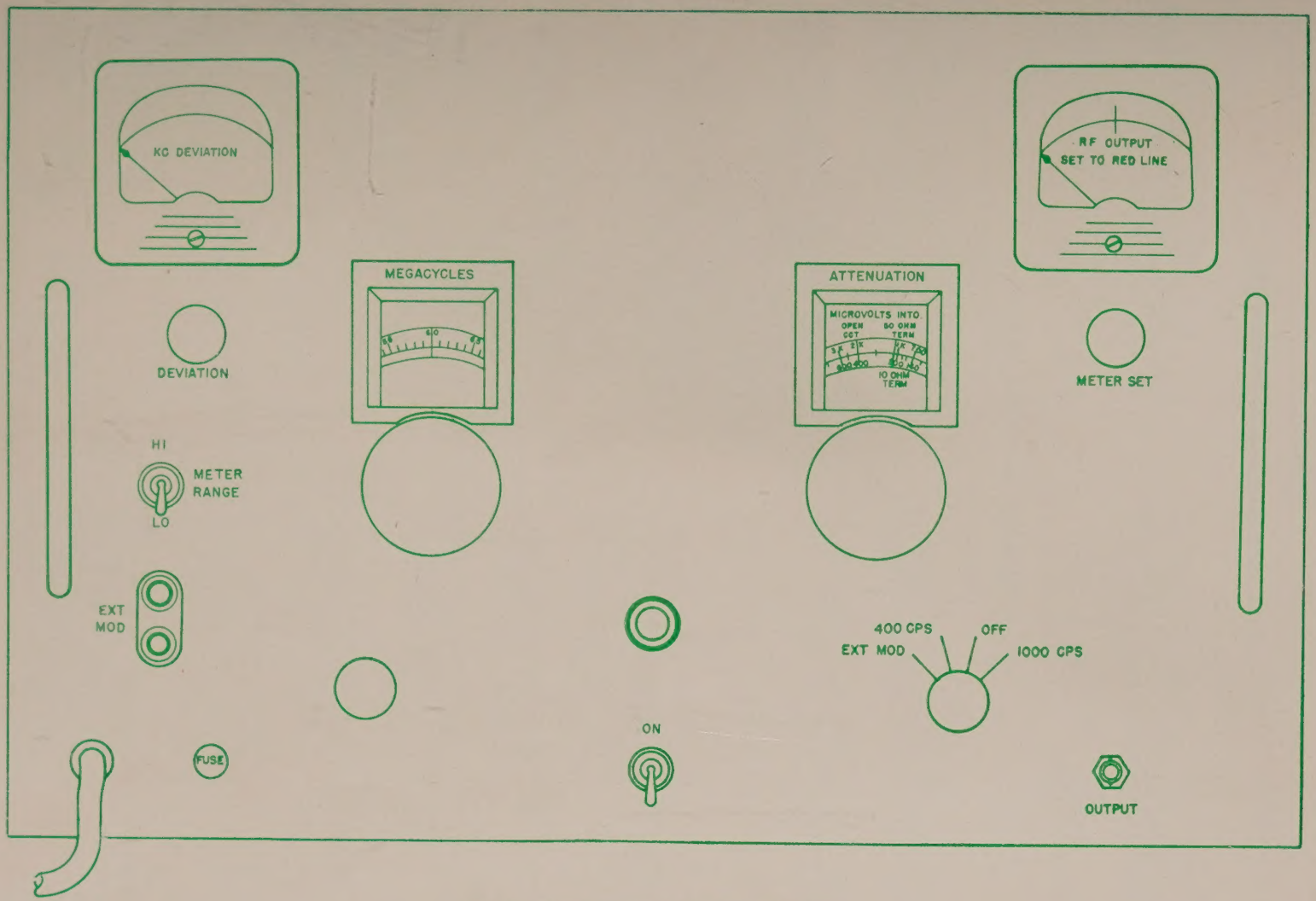


Fig. 2 Signal Generator 100A, front view.

PART II

INSTALLATION AND OPERATION

Signal Generator 100A is complete in one portable unit and is ready for use upon delivery. No permanent or special installation procedures are necessary. The following steps should be taken before operation:

a. Connect the power cable into a 115 volt, 50 to 60 cycle a-c power source.

b. If an output voltage range of .1 volt to .1 μv (microvolt) is desired, connect r-f cable assembly W1 to OUTPUT jack J3, located on the right side of the signal generator set.

c. If an output voltage range of .02 volt to .02 μv microvolt is desired, connect r-f cable assembly W2 to J3.

Controls and Instruments

CAUTION

Haphazard operation or improper setting of the controls can cause damage to electronic equipment.

CONTROLS AND THEIR FUNCTION (fig. 2)

a. The following table lists the controls of Signal Generator 100A and indicates their function:

Control	Function
MEGACYCLES tuning control	Controls the r-f output frequency of the signal generator set by varying both the oscillator tank capacitance and inductance. The tuning dial is calibrated in mc.
ATTENUATION control	Controls output voltage of signal generator. The ATTENUATION dial is calibrated in μv.
Modulation switch (S1)	Permits selection of internal modulation at 400 or 1,000 cps, or external modulation. In the OFF position, the carrier is unmodulated.
DEVIATION control (R13)	Controls frequency deviation of r-f oscillator. The meter directly above this control indicates the frequency deviation in kc.
HI-LO METER RANGE switch (S3)	Selects KC DEVIATION meter range. In LO position, the meter reads a maximum frequency deviation of 30 kc. In HI position, maximum deviation is 150 kc.
METER SET control (R33)	Adjusts plate voltage of r-f oscillator tube V3. Before taking a reading on the ATTENUATION dial, this control must be adjusted so that the pointer of the RF OUTPUT meter coincides with the red line.
Power ON switch (S2)	Connects the signal generator set to a-c power source when in ON position.
Fine tuning control	Permits fine adjustment of r-f oscillator frequency; located below and to the left of the MEGACYCLES tuning control.

b. The following controls are inside the cabinet anl are preset screw driver slot type potentiometers:

Control	Function
R-f meter calibration (R36)	Calibrates RF OUTPUT meter.
Voltage set (R29)	Controls output voltage of regulated power supply.
Hi meter set (R49)	Limits current through deviation meter in HI position of METER RANGE switch.
Lo meter set (R50)	Limits current through deviation meter in LO position of METER RANGE switch. *Note*: Always adjust LO range before adjusting HI range. HI range setting is affected by LO range control.
R-f oscillator trimmer (C14)	Adjusts frequency of r-f oscillator.

PART III

OPERATION

a. Preliminary. Set the front panel controls as follows:

Control	Function
DEVIATION	Full counterclockwise position.
METER SET	Full counterclockwise position.
Modulation switch	Off.
Power switch	Off.
METER RANGE switch	HI.

b. Starting. Connect the power cable to the a-c power source. Turn on the signal generator by throwing the power switch to the ON position. Allow one-quarter hour for warm-up.

a. Rotate the MEGACYCLES tuning dial to the desired frequency. Use the fine tuning control for fine adjustment.

b. Turn METER SET control until pointer on r-f meter coincides with red line.

c. Set modulation switch to desired modulating frequency.

d. Throw METER RANGE swith to LO for deviation from 0 to 30 kc and to HI for deviation from 0 to 150 kc.

e. Adjust DEVIATION control to required frequency deviation on KC DEVIATION Meter.

f. The r-f output now can be set by means of the ATTENUATION dial, which is calibrated in microvolts.

g. The actual voltage applied (E_L) to the load is not necessarily the same the voltage indicated (E_{IND}) on the ATTENUATION dial. To determine E_L in μv, refer to the following table:

Cable	Load Impedance Z_L	E_L
r-f cable assembly W1	Greater than 250 ohms	$E_L = E_{IND}$
(Use 50-ohm calibrating hairline.)	Less than 250 ohms	$E_L = \frac{Z_L}{Z_L + 25.5} \times E_{IND}$
r-f cable assembly W2	Greater than 100 ohms	$E_L = \frac{Z_L}{Z_L + 9} \times E_{IND}$
(Use 10-ohm calibrating hairline.)	Less than 100 ohms	

PART IV

THEORY

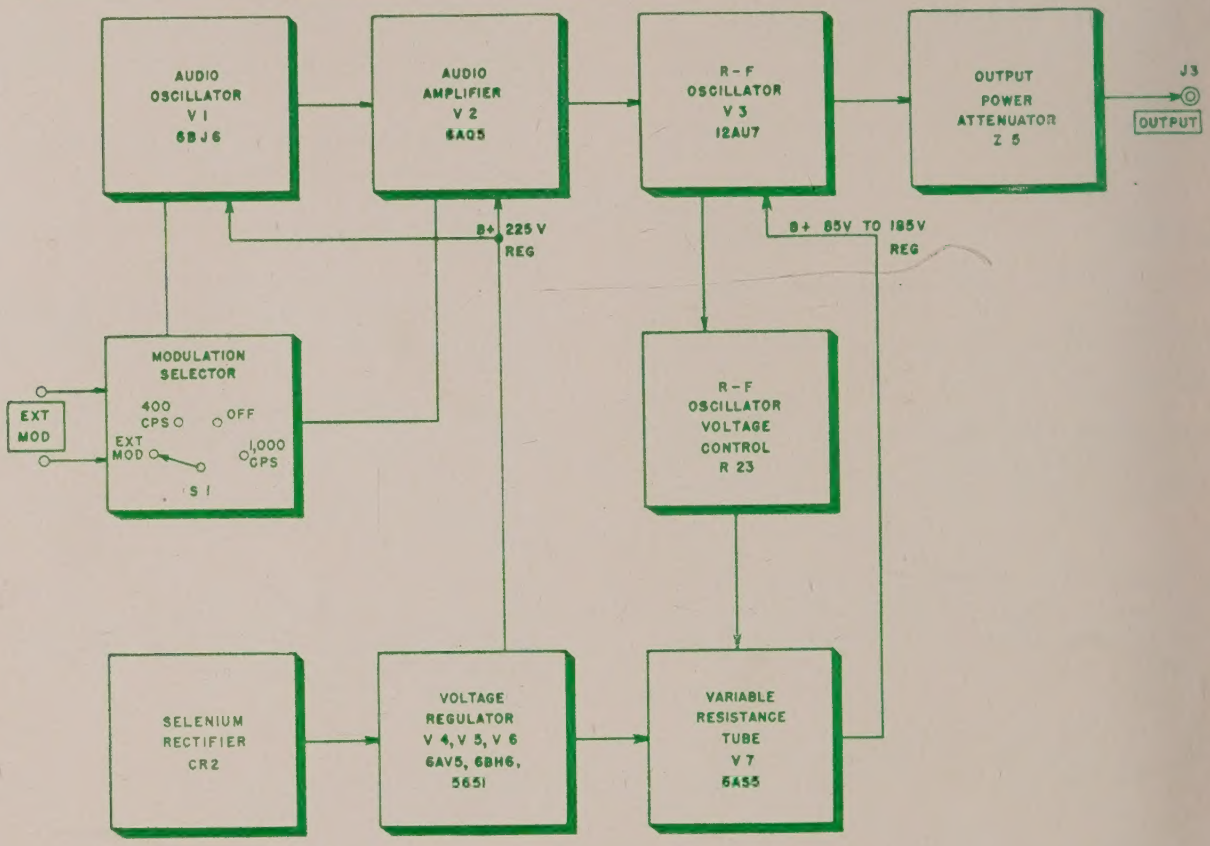


Fig. 3. Signal Generator Set 100A, block diagram.

AUDIO SECTION

For oscillations to occur in an amplifier, the feedback voltage must be in phase with the input voltage, and the overall amplification must be greater than unity.

a. ...The audio oscillator stage uses a phase shifting network consisting of series capacitors C1 through C5 and shunt resistors R1 through R5. This network feeds energy from the plate circuit of remote cut-off pentode V1 back to its grid circuit.

Since both gain and loss are somewhat uncertain, an automatic gain control circuit is incorporated in the grid circuit of V1 to maintain oscillation at the desired level and to preserve good waveform. The germanium crystal CR1 produces a control voltage by rectifying the oscillator output fed to it.

Smoothed control voltage reaches the grid of the oscillator through the last shunt resistors of the phasing network.

b. Variable resistors R49 and R50 provide means for calibrating the KC DEVIATION meter to read correctly on its HI and LO ranges. In the LO position, R49 is shorted; in the HI postion, R49 and R50 are in series. This decreases the potential drop across meter M1, permitting it to read higher voltages. Although the adjustment of R50 is independent of R49, the opposite is not true. The sequence of adjustments always should be first to adjust R50 with the METER RANGE switch S3 in the LO position; then set R49 with S3 in the HI position.

Resistor R16 is a parasitic suppressor. It tends to eliminate instability during plate current peaks. Capacitor C11 blocks the d-c component of cathode current from the meter circuit.

R. F. OSCILLATOR

The r-f oscillator (V3) is a shunt-fed Colpitts circuit whose frequency is determined by both sections of C15, and the series inductance of L1 and L2. Plate voltage is supplied through the filter sections in the casting after being regulated by variable resistance tube V7. The amplitude of oscillation is limited by grid leak R19 and blocking capacitor C12. Frequency modulation is accomplished by varying the inductance of the secondary of T1 which is in parallel with the oscillator tank circuit. This secondary is wound on a special core with variable permeability dependent on the magnetic flux density in it. The magnetic structure of the modulating yoke is such that flux produced by current in the primary of T1 appears in the secondary. A variable flux, therefore, such as is produced by varying grid voltage in the modulator tube V2, produces a variation in the secondary inductance with consequent frequency modulation of the oscillator. In order to make the deviation constant for any frequency setting it is essential that the proper ratios of the inductances of L1, L2, and T2, and the capacitance of C15 be maintained. This is accomplished by varying both L2 and C15 simultaneously. L1 is used to determine the minimum inductance of the tank, and to couple output power to the attenuator. C14 is a trimmer provided for setting the minimum tank capacitance.

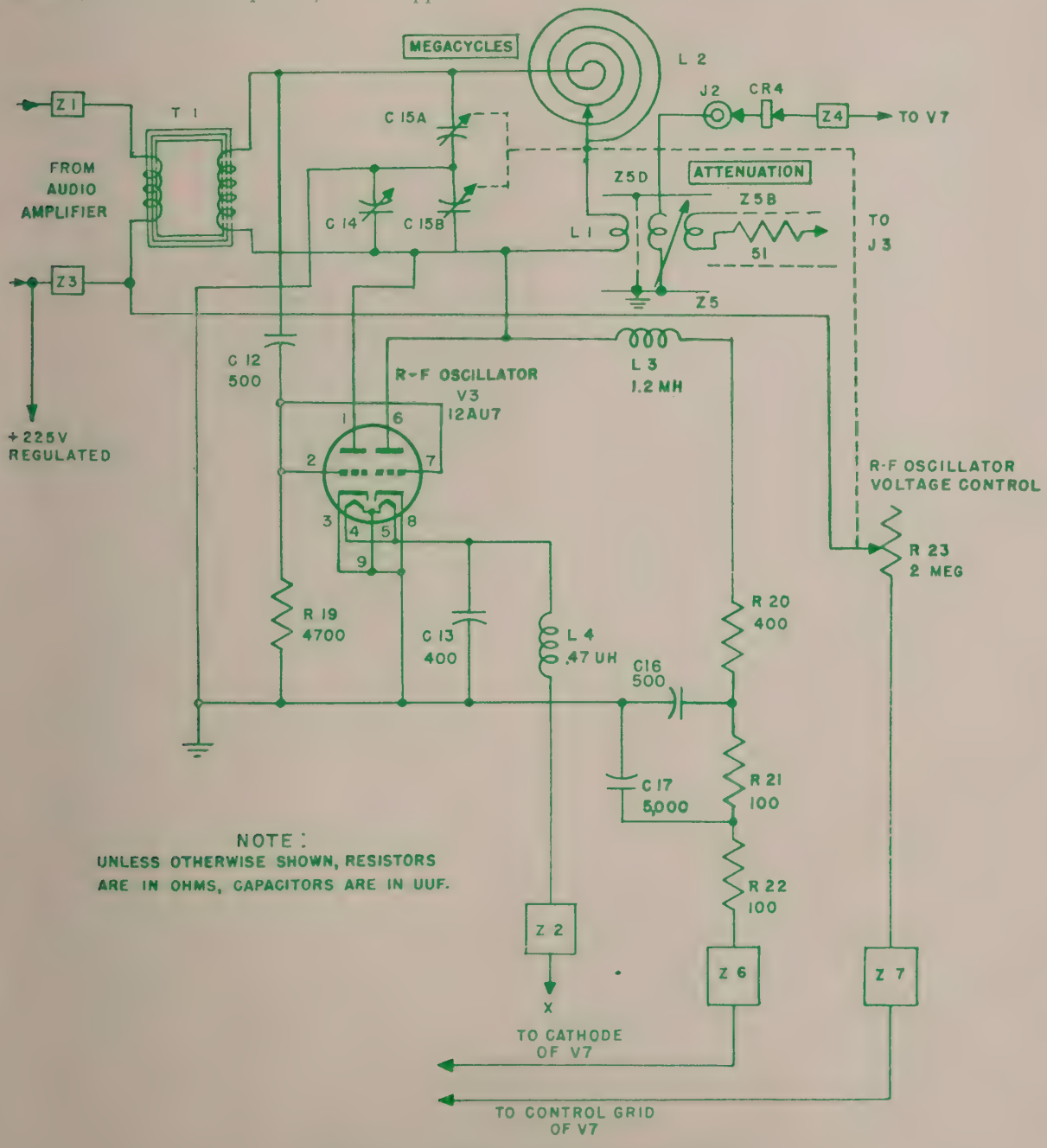


Fig. 4. R-F Oscillator, Simplified Schematic diagram.

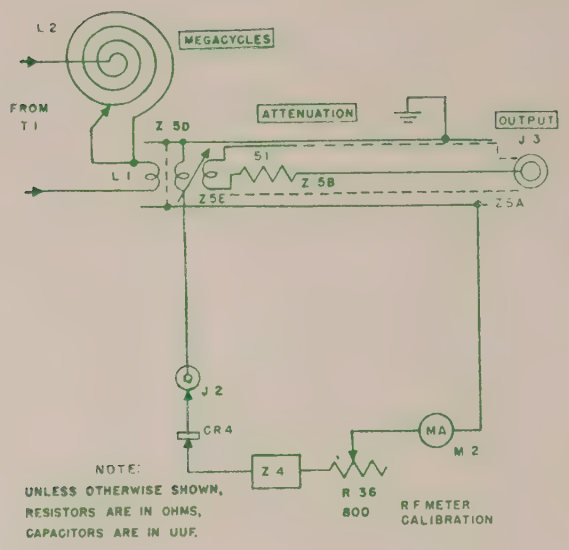


Fig.5. Output Attenuator, simplified schematic diagram

OUTPUT ATTENUATOR (Z5)

The output attenuator is a mutual inductance attenuator, in which the output voltage is controlled by varying the mutual inductance between two coils located in a tube. The oscillator tank current flows in L1, which creates an electromagnetic field in the end of the attenuator tube. The electric field is removed by a shorting wire, suitably oriented, which reduces errors resulting from capacitive coupling. The shorting wire is shown on the schematic as a dotted line to the right of L1. The magnetic field, which has a definite wave length, is propagated down the tube and induces a voltage in the movable coil, Z5E. This coil is connected to r-f OUTPUT jack J3 through a length of flexible coaxial cable, Z5A. To eliminate standing waves and to obtain the maximum power transfer, the line is terminated in its characteristic impedance by resistor Z5B at the input end while the output cable provides the proper termination at the output end.

The attenuator tube acts like a waveguide operating at a frequency far below cut-off. There is a high rate of attenuation of the magnetic field as it propagates down the tube, caused mainly by internal reflections at the input end. The attenuation rate, which is logarithmic, can be calculated very accurately; it is 31.9 db per diameter for this tube. The calibration on the dial will be seen to be logarithmic on the v scale and linear on the db scale. The attenuator input is monitored by the circuit consisting of Z5D, Z5C, Z4, R36, and M2. Z5D is a pick-up loop located just behind coil L1. A silicon crystal CR4 rectifies the r-f voltage appearing across the pick-up loop and delivers dc to meter M2. R-f bypassing and filtering takes place in Z4. R36 is a meter calibrating resistor.

MODULATION SWITCH S1

S1 is a four position three circuit rotary switch controlling the modulation and oscillator circuits. S1-A switches the grid of the audio oscillator to the correct point on the phase shift network for 400 or 1000 cycle oscillation. In the **Off** and **External Modulation** positions this grid is grounded. S1-B switches the input to the grid potentiometer for the modulator tube. 400 and 1000 cycle positions connect this input to the oscillator output; **External Modulation** position and **Off** connect the input to the External Modulation Jack and Ground respectively. S1-C switches in the additional Pi sections of the phase shift network for 1000 cycle operation of the audio oscillator.

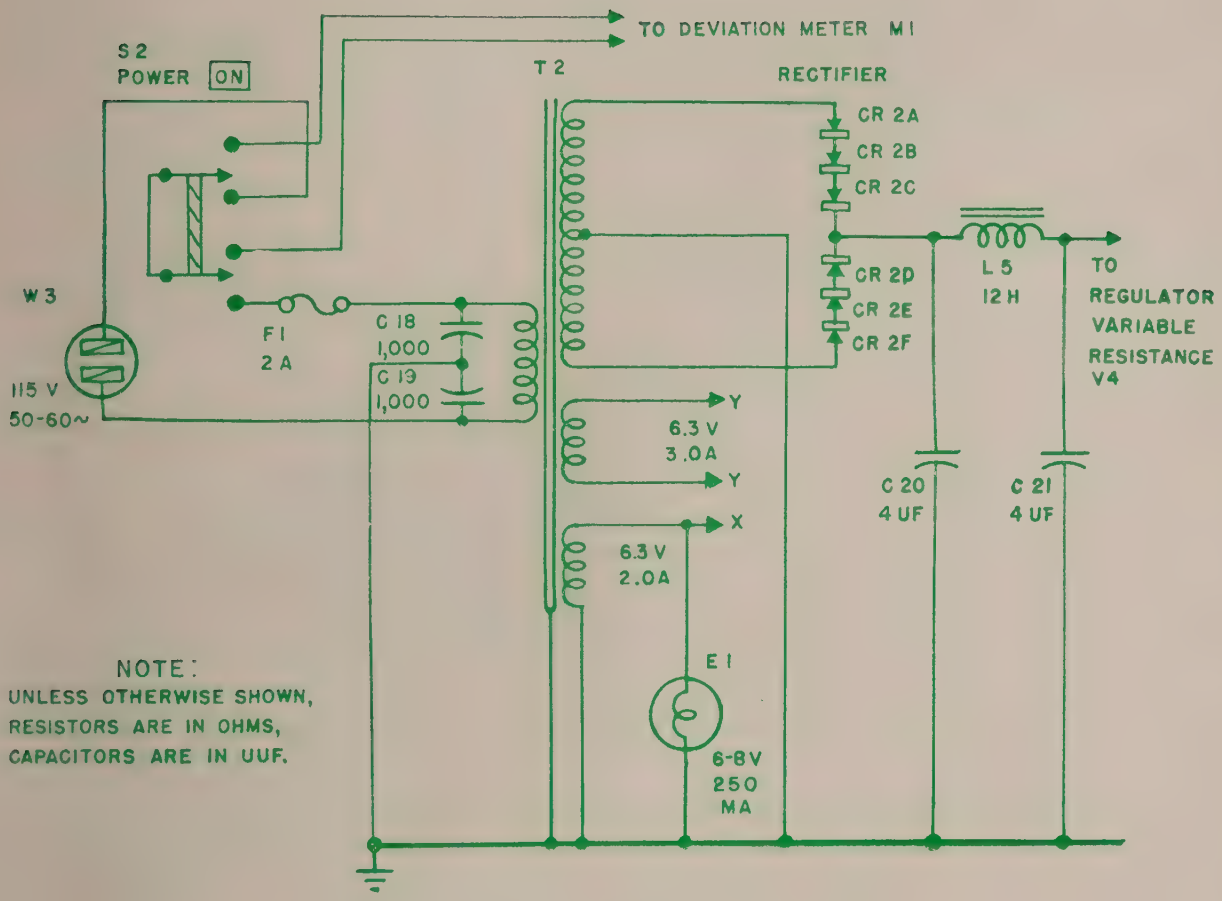


Fig. 6.—Rectifier and Filter, simplified schematic diagram

SELENIUM RECTIFIER (CR2)

The power supply consists of a power transformer (T2) whose primary winding receives power from the line through switch S2 and protective fuse F1. A pair of 1-1 filter condensers (C18 and C19) are connected from primary to chassis. The transformer has three secondary windings: 720 volts root-mean-square, center tapped, rated at 70 milli-amperes dc; 6.3 volts at 3 amperes; 6.3 volts at 2 amperes. The 720-volt winding supplies 360 volts to each side of a full-wave selenium rectifier. The 6.3-volt 3-ampere winding supplies haeter power to V4 and V7. The 6.3-volt 2-ampere winding supplies power to all other heaters. the silenium rectifier has nine selenium elements on either side, and supplies approximately 400 volts dc to the input of the filter.

The power filter is a capacitor input pi-section network consisting of a choke (L5) and two oil-filled capacitors (C20 and C21).

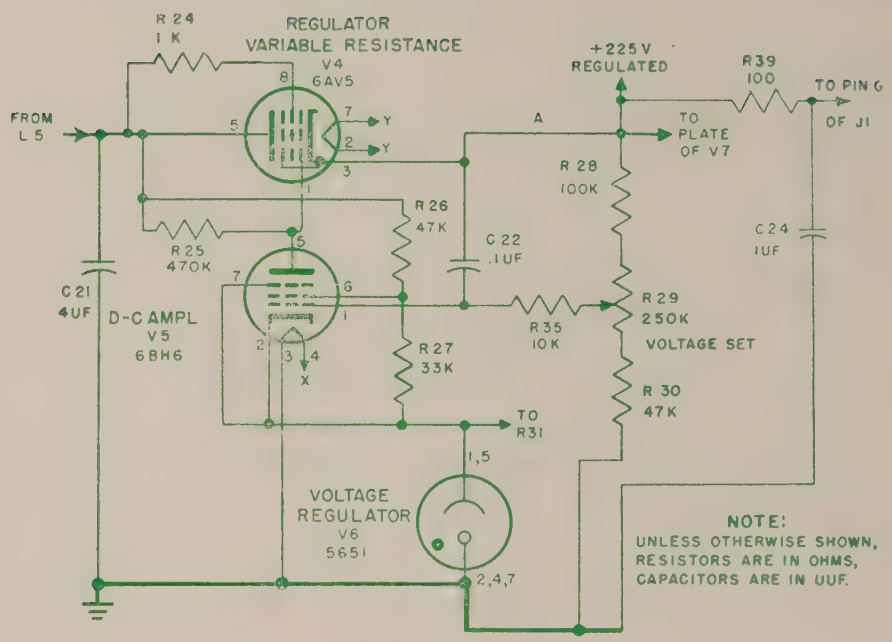


Fig. 7. Voltage Regulator Circuit, simplified diagram

VOLTAGE REGULATOR CIRCUIT

The function of the voltage regulator circuit is to supply a B+ voltage that is constant despite load or a-c line fluctuations. The circuit consists of three stages, viz., a variable resistance tube V4, a d-c amplifier V5, and a voltage regulator tube V6. V6 clamps the cathode of V5 at a constant positive potential. V5 supplies a controlling voltage to the grid of V4 which is in series with the B+ line. Therefore, the magnitude of the regulated B+ voltage will depend on the impedance of V4. This impedance varies so as to oppose changes in the regulated B+ output.

VARIABLE RESISTANCE STAGE

This stage establishes the plate potential of r-f oscillator tube V3. If this potential were constant, the oscillator output would have a different value for each carrier frequency used. The variable resistance stage stabilizes the r-f output so that only a minor manual correction is necessary.

The control grid potential is determined by the voltage divider consisting of Z3, R23, Z7, R34, and R33. Since R23 is mechaically coupled to the main tuning shaft, as the shaft rotates, R23 varies to give a voltage variation at the control grid, which counteracts the inverse hyperbolic variation that the r-f output would have with a constant plate voltage. The output therefore remains approximately constant.

Manual adjustment for fine setting of output level level is provided by potentiometer R33.

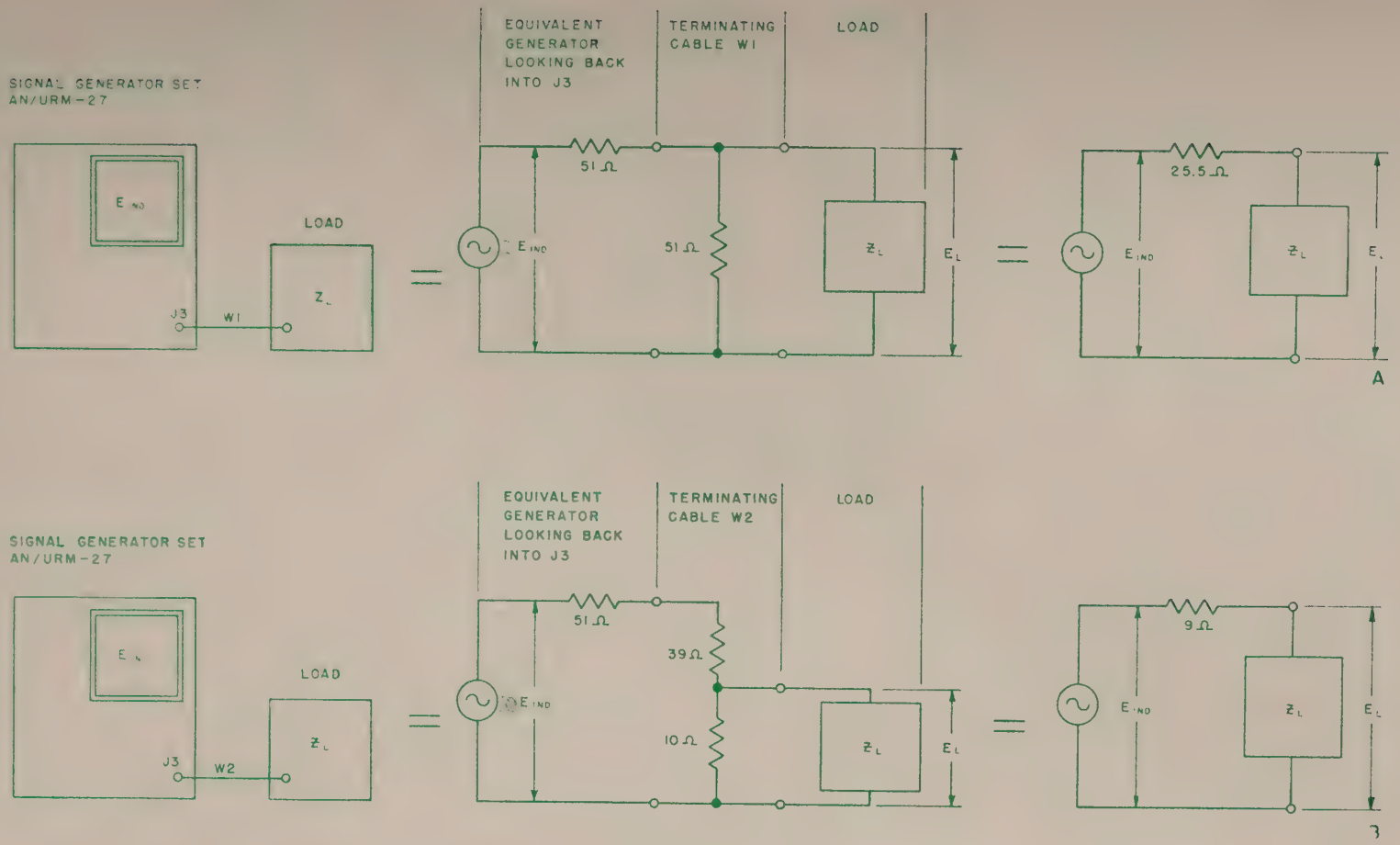


Fig. 8. R. F. Output Cables, equivalent diagrams

R-F OUTPUT CABLES

R-f cable assemblies W1 and W2 transfer the output of Signal Generator 100A to the equipment under test. Two cables are used so that two output voltage ranges are available. These cables must match the characteristic impedance of the flexible coaxial cable that connects Z5E to J3. If the r-f cables are not terminated properly, unpredictable resonance effects will cause erratic operation of the signal generator. Because of the cable terminations, the voltage E_L applied to the load (Z_L) is not necessarily the same as the voltage (E_{IND}) indicated on the ATTENUATION dial.

a. R-F Cable Assembly W1. This cable is used when a voltage range of .1 volt to .1 μv is desired. It is represented in figure 14A by a 51-ohm resistor in parallel with load Z_L. The signal generator set can be considered as a constant voltage generator in series with a 51-ohm resistor. The ATTENUATION dial indicates the voltage (E_{IND}) of the equivalent constant voltage generator. Since the two 51-ohm resistors are in parallel, they equal a 25.5-ohm resistor in series with the constant voltage generator. Therefore, according to Ohm's law,

$$E_L = \frac{Z_L}{Z_L + 25.5} \times E_{IND}$$

When Z_L is greater than 250 ohms, the difference between E_{IND} and Z_L is negligible for all practical purposes.

b R-F Cable Assembly W2. This cable is used when a voltage range of .02 volt to .02 μv is desired. It is represented in figure 14B by the two series resistors of 39 ohms and 10 ohms. The load is connected across the 10-ohm resistor. Using the same reasoning as in the preceding sub-paragraph, the actual voltage applied to the load is given by:—

$$E_L = \frac{Z_L}{Z_L + 9} \times E_{IND}$$

When Z_L is greater than 100 ohms, the difference between E_{IND} and E_L is negligible.

PART V

SERVICING

This section will serve as an aid in serving the 100A. It consists of: (1) a servicing chart listing the symptoms, probable difficulty and its correction; (2) a diagram of voltages at the tube sockets; (3) a bottom view of the chassis, with labels; and (4) a listing of d-c resistances of transformers.

CAUTION: Major repairs should not be undertaken without first contacting the factory.

Servicing Chart

SYMPTOM	PROBABLE TROUBLE	CORRECTION
1. Heaters fail to light when power switch S2 is turned ON.	1. Fuse blown. Transformer T2 winding open or shorted Defective switch S2.	1. Replace F1. If it blows again, determine the fault before replacing. Make continuity tests of all transformer windings. Replace T2 if faulty. Replace switch.
2. No deflection on RF OUTPUT meter M2.	2. Defective crystal CR4. Defective tube V3. Defective tube V7. Loose contact on connectors, J1 or P1.	2. Replace crystal. Replace V3. Replace V7. Tighten and clean
3. No reflection on KC DEVIATION meter M1.	3. Defective tube V1. Defective tube V2. Defective rectifiers CR1 or CR3. Open capacitor C8.	3. Replace V1. Replace V2. Use external modulation source to localize trouble at V1. Replace CR1 or CR3. Replace C8.
4. Regulator tube V6 fails to glow.	4. Defective rectifier SR2. Defective regulator V6. Shorted B+ supply. Defective capacitor C20 or C21. Defective coil L5.	4. Replace SR2. Replace V6. Localize by pulling V4 or V7 out of socket or by removing P1 from J1. Replace C20 or C21. Replace L5.
5. Pilot light E1 fails to light. All heaters light.	5. Faulty pilot light.	5. Replace E1.
6. Pilot light E1 fails to light. Heaters of tubes V4 and V7 fail to light.	6. Open 2-ampere winding of transformer T2.	6. Replace T2.
7. Cannot obtain full-scale deflection on M1 on HI range.	7. Defective V2. Maladjustment of R17.	7. Replace V2. Readjust R17.
8. Cannot obtain midscale setting of M2.	8. Defective V3. Defective CR4. Reduced B+ voltage. Defective R36.	8. Replace V3. Replace CR4. Check B+ voltage at V4 and V7. Replace R36.
9. Erratic operation of M1.	9. Defective switch S1. Defective potentiometers R49 or R50.	9. Clean contacts. If trouble persists, replace S1. Replace R49 or R50.
10. Meter M1 will not return to zero.	10. Defective V4, V5, or V6 causing parasitic oscillation in power supply.	10. Replace, one at a time, V4, V5, and V6.

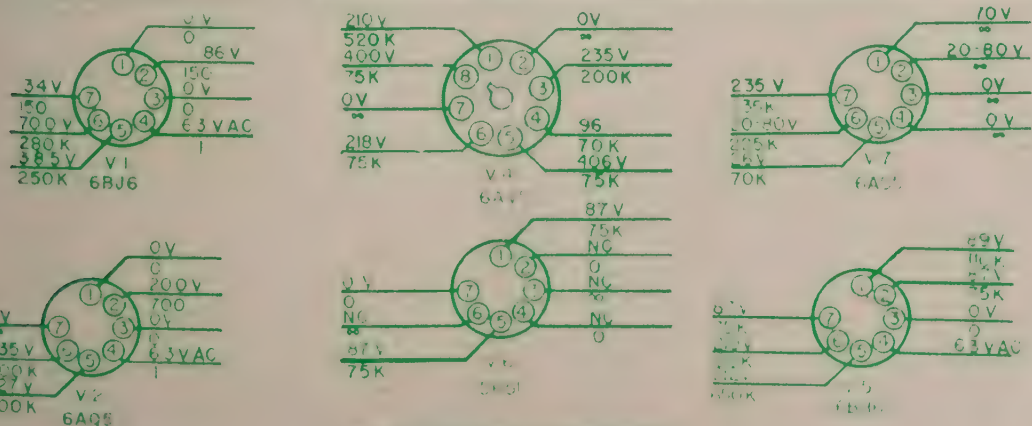


Fig. 9. Voltages at Tube Sockets

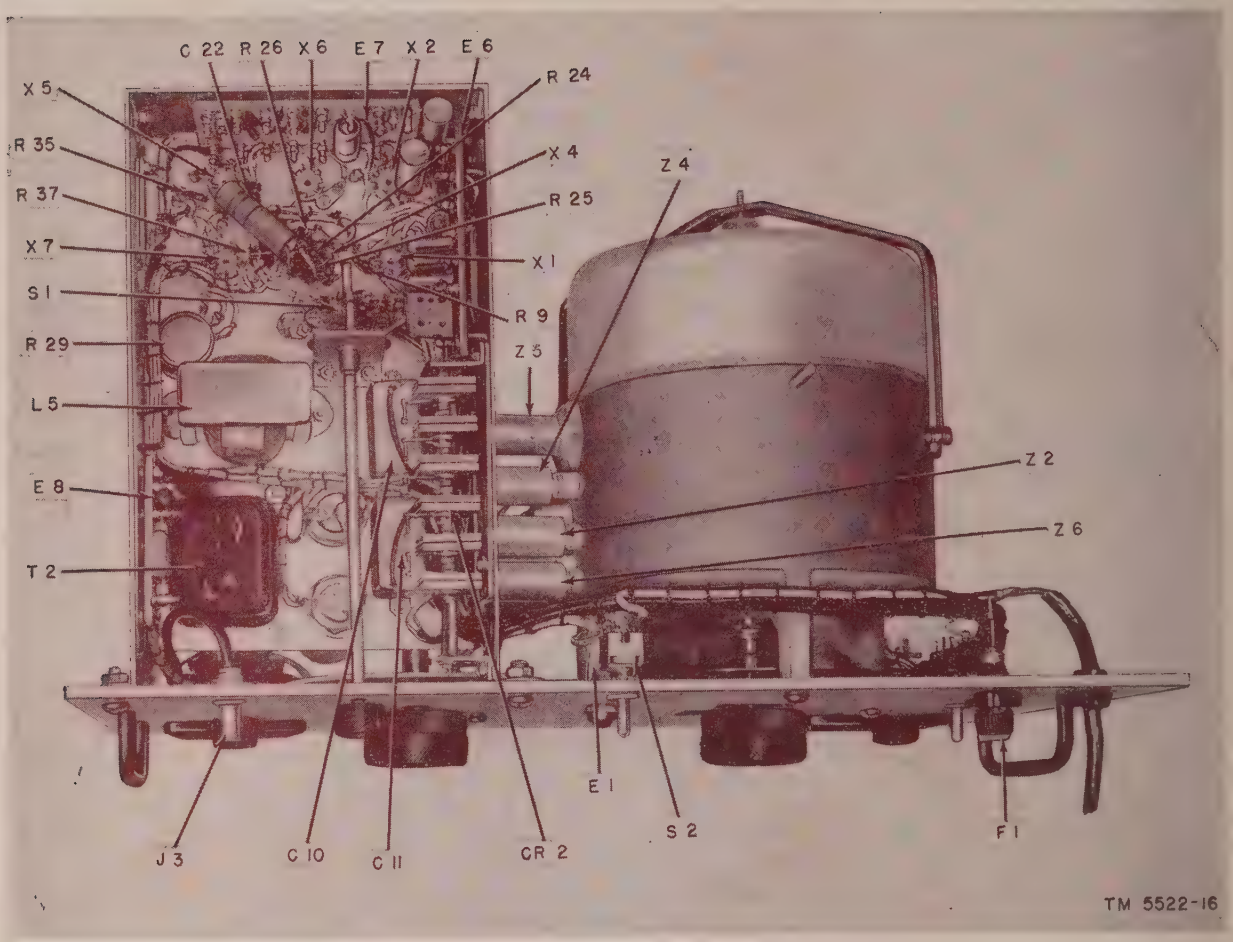
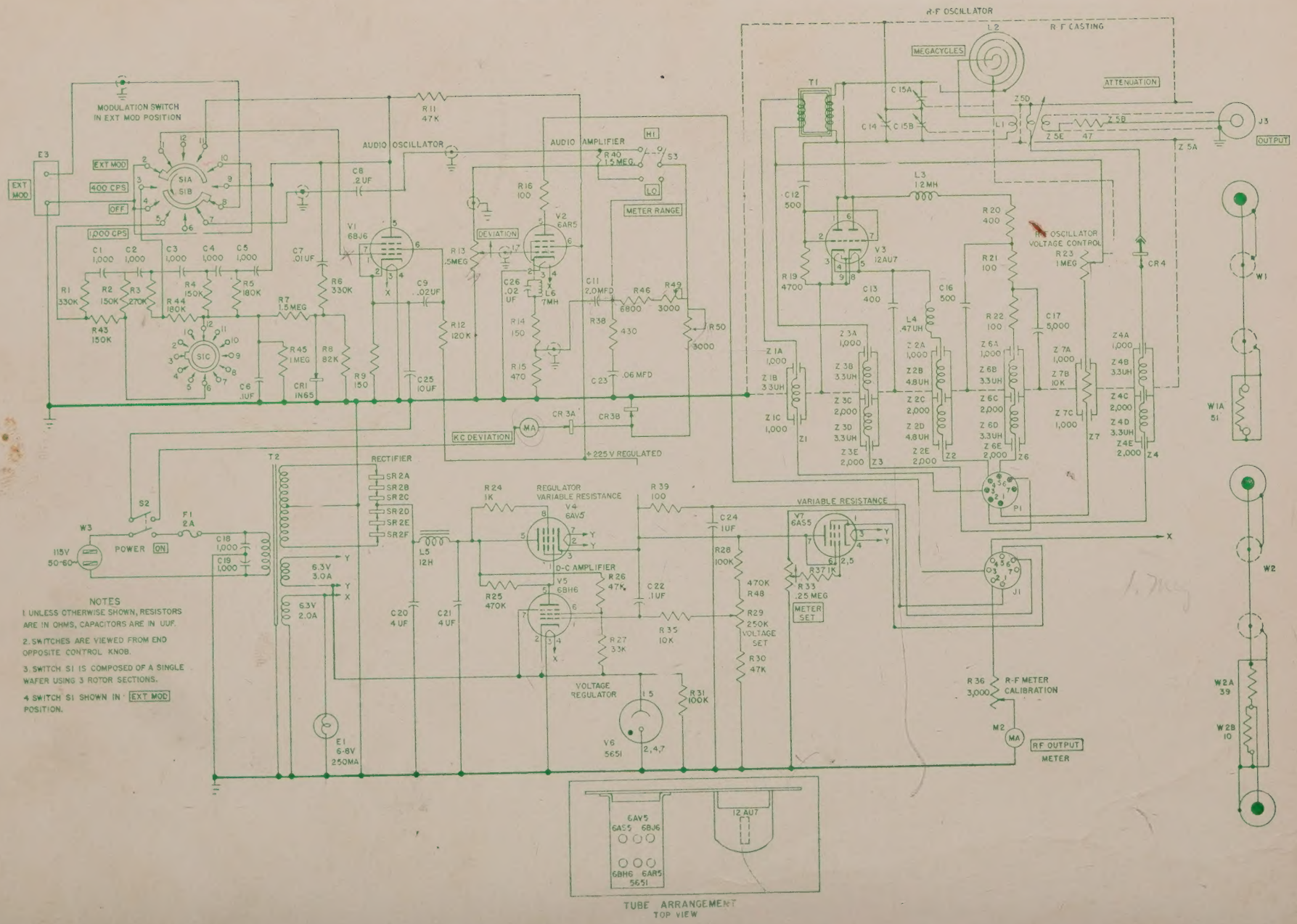


Fig. 10. Signal Generator Set 100A, bottom view of chassis

RESISTANCE OF TRANSFORMERS

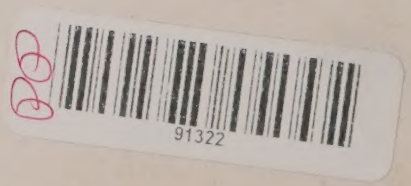
TRANSFORMER OR COIL	TERMINALS	OHMS
T1	2 leads 2 solder lugs	Less than .1 ohm Less than .1 ohm
T2	Black-black Red-white (center tap) Red-red Green-green (gray center tap not used) Yellow-yellow	5.9 320 640 .4 .4
L1	Coil ends	Less than .1 ohm
L2	Solder terminals	Less than .1 ohm
L3	Leads	.35
L4	Leads	.14
L5	Leads	310



NOTES

1. UNLESS OTHERWISE SHOWN, RESISTORS ARE IN OHMS, CAPACITORS ARE IN UUF.
2. SWITCHES ARE VIEWED FROM END OPPOSITE CONTROL KNOB.
3. SWITCH S1 IS COMPOSED OF A SINGLE WAFER USING 3 ROTOR SECTIONS.
4. SWITCH S1 SHOWN IN EXT MOD POSITION.

Fig. 11. Schematic Diagram.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